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CERTIFICATE OF FACSIMILE TRANSMISSION TO THE UNITED STATES PATENT AND TRADEMARK OFFICE

DATE: January 16, 2007

Mail Stop: AF	: RE:
Art Unit: 3768	: Serial No.: 10/796,634
Fax: 571-273-8300	: Applicant: Sven Brekke, et al.
From: Dean D. Small	: Filed: March 9, 2004
	: GEHC Dkt. No.: 130394 (SPLC 1011)
	: Title: TRIGGER EXTRACTION FROM ULTRASOUND DOPPLER SIGNALS

DOCUMENTS SUBMITTED WITH TRANSMISSION:

- Certificate of Facsimile Transmission (1 pg.)
- Amendment Transmittal (1 pg.)
- Amendment in Response to the Final Office Action dated November 16, 2006 (13 pgs.)

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Date: January 16, 2007

Dean D. Small, Reg. No.: 34,730

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Date: January 16, 2007

Dean D. Small, Reg. No.: 34,730

Date docketed: 1-18-07
Response Nee ed: After Final Amdt. htr
Initial Due Date: 1-16-07
Last Due Date:
Docketed by: UVS

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Sven Brekke, et al.	Group No.: 3768
Serial No.:	10/796,634	Examiner: Jaworski, Francis J.
Filed:	March 9, 2004	
For:	TRIGGER EXTRACTION FROM ULTRASOUND DOPPLER SIGNALS	

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P.O. Box 1450
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STATUS

2. Applicant
   X is other than a small entity.

EXTENSION OF TERM

X Applicant believes that no extension of term is required. However, this conditional petition is being made to provide for the possibility that applicant has inadvertently overlooked the need for a petition for extension of time.

FEE FOR CLAIMS

X No additional fee for Claims is required.

X If any additional extension and/or fee is required, charge Deposit Account No. 07-0845.

AND/OR

X If any additional fee for claims is required, charge Deposit Account No. 07-0845.

Date: January 16, 2007

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PATENT
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Applicant: Sven Brekke, et al	Art Unit: 3768
Serial No.: 10/796,634	Examiner: Jaworski, Francis J.
Filed: March 9, 2004	
For: TRIGGER EXTRACTION FROM ULTRASOUND DOPPLER SIGNALS	

AFTER FINAL AMENDMENT

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In response to the Final Office Action dated November 16, 2006, please amend the above-identified patent application as follows:

WHAT IS CLAIMED IS:

1. (Currently Amended) A trigger extraction system for obtaining an event trigger for an event occurring in a region of interest while the region of interest is scanned by an ultrasound imaging system, the ultrasound imaging system having image memory and a display, the image memory storing image data defining a series of ultrasound images of a region of interest, the display displaying the ultrasound images, the trigger extraction system comprising:

a processor;

a memory coupled to the processor; and

a trigger extraction program stored in the memory for execution by the processor, the trigger extraction program comprising instructions for accessing ultrasound trigger data obtained from a trigger region, analyzing the trigger data for a trigger characteristic, and storing an event trigger based on the trigger characteristic, the trigger data being recorded with an ultrasound beam defocused in an azimuth direction, the event trigger being used in connection with controlling display of the ultrasound images, wherein the instructions for analyzing comprise instructions for filtering the trigger data, the filter utilizing a cutoff frequency that is set based on the trigger characteristic independent of the image data.

2. (Previously Presented) The trigger extraction system of claim 1, where the trigger region at least partially differs from the region of interest.

3. (Previously Presented) The trigger extraction system of claim 1, wherein the trigger data comprises Doppler data with a phase component, and wherein the trigger extraction program further comprises instructions for high pass filtering the phase component based on the trigger characteristic.

4. (Previously Presented) The trigger extraction system of claim 1, where the instructions for analyzing the trigger data comprise instructions for averaging the trigger data over at least a portion of a depth range.

5. (Original) The trigger extraction system of claim 4, where the instructions for averaging the trigger data comprise instructions for averaging high pass filtered phase components of the trigger data.

6. (Original) The trigger extraction system of claim 4, wherein the instructions for analyzing the trigger data further comprise instructions for interpolating an additional event trigger.

7. (Previously Presented) The trigger extraction system of claim 1, where the trigger data and image data are recorded using ultrasound beams having different values for at least one acoustic parameter.

8. (Previously Presented) The trigger extraction system of claim 1, wherein the instructions for analyzing comprise instructions for determining at least one of a signal maxima and signal minima.

9. (Cancelled)

10. (Original) The trigger extraction system of claim 1, wherein the region of interest is a fetal heart.

11. (Original) The trigger extraction system of claim 10, wherein the trigger region comprises fetal tissue.

12. (Currently Amended) A machine readable medium storing instructions that cause an ultrasound imaging system that obtains images of a region of interest to perform a method, the ultrasound imaging system having image memory and a display, the image memory storing image data defining a series of ultrasound images of a region of interest, the display displaying the ultrasound images, the method comprising:

accessing ultrasound trigger data obtained from a trigger region, the trigger data being recorded with an ultrasound beam defocused in an azimuth direction;

analyzing the trigger data for a trigger characteristic; and

storing an event trigger based on the trigger characteristic, the event trigger being used in connection with controlling display of the ultrasound images<u>, where the trigger data comprises Doppler data, and wherein the step of analyzing comprises high pass filtering the Doppler data</u>

utilizing a cutoff frequency that is set based on the trigger characteristic independent of the image data.

13. (Previously Presented) The machine readable medium of claim 12, wherein the trigger region at least partially differs from the region of interest.

14. (Cancelled)

15. (Original) The machine readable medium of claim 12, wherein the step of analyzing comprises the step of averaging a high pass filtered component of the trigger data.

16. (Previously Presented) The machine readable medium of claim 12, wherein the trigger data and image data are recorded using ultrasound beams having different values for at least one acoustic parameter.

17. (Original) The machine readable medium of claim 12, where the step of analyzing comprises the step of determining a signal extreme from the trigger data.

18. (Original) The machine readable medium of claim 12, wherein the step of analyzing comprises the steps of determining high pass filtered trigger data, and determining at least one of a signal maxima and signal minima of the high pass filtered trigger data.

19. (Original) The machine readable medium of claim 12, wherein the region of interest is a fetal heart.

20. (Original) The machine readable medium of claim 19, wherein the trigger region comprises fetal tissue.

21. - 29. (Cancelled)

30. (Currently Amended) A method for obtaining an event trigger for an event occurring in a region of interest utilizing an ultrasound imaging system, the ultrasound imaging system having image memory and a display, the image memory storing image data defining a series of ultrasound images of a region of interest, the display displaying the ultrasound images, the method comprising:

accessing ultrasound trigger data from a trigger region, the trigger data being recorded with an ultrasound beam defocused in an azimuth direction;

analyzing the trigger data for a trigger characteristic; and

storing an event trigger based on the trigger characteristic, the event trigger being used in connection with controlling display of the ultrasound images, wherein the trigger data comprises Doppler data, and wherein the analyzing comprises high pass filtering the Doppler data utilizing a cutoff frequency that is set based on the trigger characteristic independent of the image data.

31. (Cancelled)

32. (Previously Presented) The method of claim 30, wherein the step of analyzing comprises the step of averaging the trigger data in a depth range.

33. (Original) The method of claim 30, wherein the step of analyzing comprises the step of averaging a high pass filtered component of the trigger data.

34. (Original) The method of claim 30, wherein the step of analyzing comprises the step of interpolating an additional event trigger.

35. (Original) The method of claim 30, where the step of analyzing comprises the step of determining a signal extreme from the trigger data.

36. (Original) The method of claim 30, wherein the step of analyzing comprises the steps of determining high pass filtered trigger data, and determining at least one of a signal maxima and signal minima of the high pass filtered trigger data.

37. (Original) The method of claim 30, wherein the region of interest is a fetal heart.

38. (Original) The method of claim 37, wherein the trigger region comprises fetal tissue.

39. - 46. (Cancelled)

47. (Currently Amended) An ultrasound imaging system comprising:

an ultrasound probe for obtaining ultrasound trigger data from a trigger region intersecting a region of interest, the ultrasound imaging system having image memory and a display, the image memory storing image data defining a series of ultrasound images of a region of interest, the display displaying the ultrasound images;

a processor;

a memory coupled to the processor;

a trigger extraction program stored in the memory for execution by the processor, the trigger extraction program comprising instructions for accessing the ultrasound trigger data, analyzing the trigger data for a trigger characteristic, and storing an event trigger based on the trigger characteristic, the trigger data being recorded with an ultrasound beam defocused in an azimuth direction, wherein the trigger data comprises Doppler trigger data comprising a phase component, and wherein the instructions for analyzing the trigger data comprise instructions for high pass filtering the phase component to obtain filtered data, averaging the filtered data to obtain averaged data, determining a signal extreme of the averaged data to determine the event trigger;

an image display program stored in the memory for execution by the processor, the image display program comprising instructions for accessing the event trigger and for displaying at least one image in a sequence of images in synchronism with the event trigger; and

a display for displaying the sequence of images.

48. (Cancelled)

49. (Cancelled)

50. (Previously Presented) The ultrasound imaging system of claim 47, further comprising a beamformer that defocuses the ultrasound beam in the azimuth direction and in an elevation direction.

51. (Original) The ultrasound imaging system of claim 47, wherein the region of interest is a fetal heart.

52. (Original) The ultrasound imaging system of claim 47, wherein the trigger region comprises fetal tissue.

53. (Cancelled)

54. (Original) The ultrasound imaging system of claim 53, further comprising the step of interpolating to obtain the event trigger.

55. (Original) The ultrasound imaging system of claim 47, wherein the instructions for analyzing the trigger data comprise instructions for determining a signal extreme from signal values determined by:

s(t) = Im(mean(R1(r, theta, t))), where Im() represents an imaginary part of mean(R1(r, theta, t)), R1 is an imaginary part of autocorrelation of lag one, r represents depth, theta represents a steering angle, and t represents time.

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REMARKS

Claims 1-47 and 50-55 were pending in the present application, from which claims 9, 14, 21-29, 31, 39-46, 48-49 and 53 have been cancelled. It is respectfully submitted that the pending claims define allowable subject matter.

The claims have been rejected under 35 U.S.C. § 103 as being obvious over various combinations of prior art including Brekke, Hossack, Seward, Clifton, Omiya, Jackson, Iinuma, Yamazaki and Moehring. Applicants respectfully traverse these objections for reasons set forth hereafter.

The pending independent claims have been amended to incorporate limitations of previously dependent claims. In particular, the limitations of claims 9, 14, 31 and 53 have been added to their respective independent claims 1, 12, 30 and 47, respectively. It is submitted that the pending claims define allowable subject matter.

Claim 1 recites, among other things, instructions for filtering the trigger data where the filter utilizes a cut off frequency that is set based on the trigger characteristic independent of the image data. Claim 12 has been amended to further define the trigger data to comprise Doppler data and the analyzing operation to comprise high pass filtering the Doppler data utilizing a cut off frequency that is set based on the trigger characteristic independent of the image data. Claim 30 has been amended to further define the trigger data to comprise Doppler data and the analyzing to comprise high pass filtering the Doppler data utilizing a cut off frequency that is set based on the trigger characteristic independent of the image data. Claim 47 has been amended to further define that the trigger data comprises Doppler trigger data comprising a phase component and the analyzing to include instructions for high pass filtering the phase component to obtain filtered data, averaging the filter data to obtain the averaged data and determine a signal extreme of the averaged data to determine the event trigger. The foregoing limitations are neither taught or suggested by prior art.

In the outstanding Office Action, it is acknowledged that the Brekke article does not address high pass filtering. However, it is maintained nonetheless that it would have been obvious in view of Iinuma or Yamazaki or Moehring to set a high pass filter on phase detected Doppler data "since if one wishes to track valve motion or blood flow then low frequency tissue motion must be filtered". It is further maintained that it would have been obvious in view of

Iinuma to eliminate low velocity movement since fixed locational change should be filter eliminated to derive net valve motion. It is alternatively maintained that would have been obvious to add high pass filtering in view of Moehring to set a high pass filter in applications specific fashion so as to eliminate bruit, for example, from Doppler flow data.

It is respectfully submitted that a prima facia case of obviousness has not been set forth as the secondary references to Iinuma, Yamazaki and Moehring do not establish a legitimate reason to modify the system described in the Brekke article to include a high pass filter as claimed for use with event trigger data. It is implicitly acknowledged that neither Iinuma, Yamazaki nor Moehring are concerned at all or describe any technique for extracting trigger data from the ultrasound data.

Iinuma describes an ultrasound diagnostic apparatus that is concerned with tracking large motion of tissue which exceeds an individual sample volume. In the Summary of Iinuma's invention it is noted that the first object is to easily track a position of a specific portion very accurately in various types of clinical examinations. Towards this end, a tracking processor 19A is used (as shown in Figure 9) to track the velocity of a tracking point. A motion distance is calculated and the calculated motion distance is added to a depth of the tracking point to calculate the depth of the next tracking point. The tracking process quantizes the depth of the tracking point to obtain the Y coordinate of the next tracking point. The process of Figure 9 is described at column 6, line 29-column 7.

The undersigned has reviewed the discussion of the tracking process and nowhere has it been identified where Iinuma discusses the use of the high pass filter in connection with the tracking process. In the outstanding Office Action, column 7, lines 7-38 of Iinuma is cited as the suggested support for the examiner's position as to why it would have been obvious to modify the system of the Brekke article to include a high pass filter that filters the phase detected Doppler data. The undersigned disagrees. The cited section Iinuma does not describe the use of a high pass filter for tracking or any other reason.

The undersigned has conducted a word search of the text of the '645 Patent and identified other discussions of filters, such as in connection with the noise reduction section beginning at column 4, in the real-time processing section at column 5 and in the discussion of a prior art system at column 4, lines 1-9. However, none of the above cited sections of Iinuma teach or suggest any reason to utilize high pass filtering to filter trigger data where the filter

characteristics are set based on trigger characteristics independent of the image data. In Iinuma, in the noise reduction section which uses a high pass filter 17A, the high pass filter is specifically used to reduce noise in the image. Thus, the high pass filter 17A of Iinuma is specifically designed based on the image data. In the real-time processing section of Iinuma, an MTI filter is discussed yet the MTI filter is also intended to provide band pass filtering for B-mode image data. Thus, the MTI filter is similarly designed based on image data. Nowhere does Iinuma teach or suggest the use of a high pass filter for any reason other than for use with image data. The person of ordinary skill would not arbitrarily take the high pass filter, used for a different reason, as in Iinuma, and reconstruct such a high pass filter for an entirely separate and distinct purpose, namely to filter trigger data.

Further, as noted above, the first objective of Iinuma's invention is to track the position of a specific portion of the image. Each of the pending claims state that the trigger data is recorded from a ultrasound beam that is defocused in the azimuth direction. Focusing of the ultrasound beam in the azimuth direction would necessarily introduce an error or a lack of precision in connection with resolution. Therefore, it is inconsistent to maintain that the person of ordinary skill would of pick and chose the specific discussion from Iinuma regarding the use of a high pass filter from Iinuma and then redesign such a high pass filter to filter trigger data where the filter is based, not on image data but on trigger characteristics. Iinuma's filters are all designed based on particular image data characteristics that Iinuma desires to improve in the process of tracking the specific location of an object.

There is no suggestion within the Brekke article that the trigger data obtained through Brekke method is deficit in any manner or would suffer from a problem that would be overcome by the addition of a high pass filter of the type taught by Iinuma for the reasons that Iinuma includes the high pass filter. Thus, it is respectfully submitted that the person of ordinary skill would not have been motivated to modify the system of the Brekke to add a high pass filter as claimed, based on Iinuma's secondary teachings.

Further, the alternative secondary references to Yamazaki and Moehring fail to make up for the deficiencies of the Brekke article. The Yamazaki describes an ultrasound system that is concerned with improving the ability to display low velocity band images which are available in tissue Doppler imaging. Yamazaki describes certain filter options at column 7 that may used in connection with removing unnecessary signal components such valvular motion signal

components and the like (column 7, lines 16-26). However, again Yamazaki's filter is designed to provide a particular type of diagnostic image, namely an image that displays color images of motion of tissue scanned, among other things. Therefore, Yamazaki's filters are set with these imaging goals in mind. Yamazaki does not describe trigger extraction or the filtering of trigger data. Thus, it similarly follows that the person of ordinary skill would not have been motivated to add Yamazaki's filter to the system of the Brekke article given that Yamazaki's filters are designed to provide certain image characteristics in the resulting displayed image, whereas the trigger signals of the Brekke article are used for an entirely different reason and to identify an entirely different physiologic information. Thus, the claimed filter that utilizes a cut off frequency that is set based on trigger characteristics independent of image data would not have been obvious based on the combined teachings of Brekke and Yamazaki. The cut off frequency for filter based on a trigger characteristic would differ from the shape of filters used in Yamazaki's system when identifying motion of tissue to be displayed in color.

The secondary teachings of Moehring also fail to make up for the deficiencies of Iinuma and Yamazaki. Moehring describes a Doppler ultrasound system for monitoring blood flow and hemodynamics. In the paragraph 37 of Moehring (cited in the outstanding Office Action), Moehring indicates that a high pass filter may be utilized to filter a Doppler signal to remove from the Doppler signal "bruit signals" which differ from the Doppler shifts associated with blood flow. A bruit signal appears in a Doppler spectrum due to periodic tissue movement having a frequency in the audio range and excursion distance of less than a wavelength of ultrasound. (paragraph 7). Moehring suggests using a high pass filter to remove bruit signals, yet similar to the deficiencies of Iinuma and Yamazaki, Moehring's high pass filter is intended to filter the image data. Similarly, the parameters of the high pass filter are set to pass image data that is of desire, while blocking bruit signals that are not part of the desired image data. Thus, Moehring also teachings a high pass filter, the characteristics for which are based on the image data.

Thus, it is submitted that each of the secondary references to Iinuma, Yamazaki and Moehring teach only the use of filters in connection with obtaining various image data information and thus basing such filters on the image data. Trigger characteristics of interest in the claimed invention are separate and distinct from the image data. Thus, the filter characteristics would similarly be different from and independent of the image data. There is no

suggestion within the prior art to add a filter in the claimed manner nor is there any acknowledgement of a problem that would be experienced by the system of the Brekke article or a solution to such (non-existent) problem that renders obvious the claimed filters.

In view of the foregoing, it is respectfully submitted that each of the pending independent claims are distinct and non-obvious.

Finally, the undersigned reiterates the arguments of record that the prior art fails to teach or suggest the use of an ultrasound beam defocused in the azimuth direction to obtain trigger data. As explained previously, the prior art fails teach or suggest any such structure. In the outstanding Office Action, no additional grounds have been set forth as to why it would have been obvious to defocus the ultrasound beam of the Brekke article in the azimuth direction. As noted in the present application, focusing the ultrasound beam in the azimuth direction allows for a reduced number of beams to cover a scan area when obtaining trigger data. None of the secondary references are concerned with obtaining trigger data. Therefore, it necessarily follows that none of the secondary references suggest how to construct an ultrasound beam for obtaining trigger data. All of the secondary references are concerned with obtaining imaging information of various types (e.g., B-mode, color flow data and the like). The focusing and scanning techniques associated with obtaining imaging data are not the same as and are different from the ultrasound parameters and scanning techniques associated with obtaining trigger data. Therefore, the teachings of the prior art regarding the focusing and scanning of ultrasound beams to obtain image data does not serve as a legitimate basis to the person of ordinary skill in deciding how to control and manage focusing and scanning of an ultrasound beam obtaining non-image data, namely trigger data.

In view of the foregoing comments, it is respectfully submitted that the pending claims define allowable subject matter. Should anything remain in order to place the present application in condition for allowance, the Examiner is kindly invited to contact the undersigned at the telephone number listed below.

Respectfully Submitted,

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